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ABSTRACT

The effects of student instructional preference on performance in an engineering course offered both by Personalized Instruction (PSI) and lecture/discussion methods were explored in a study of 113 university sophomores and juniors. In lieu of random assignment to instruction mode, this study employed self-selection, the most common situation in higher education. The predictive validity of the Friedman-Stritter Instructional Preference Questionnaire (IPQ) was also examined. The following questions were addressed: (1) Can modality choice be predicted? (2) Are there differences in final examination performance by self-selected treatment group? (3) Do students whose choice of instructional modality matches their instructional preference demonstrate superior final examination performance? and (4) Are students better matched to self-selected modality more likely to complete the course? The lecture students showed superior performance over the PSI students on a common final exam. It is suggested that previously recorded beneficial effects of PSI may diminish under conditions of free student choice. The attitudinal measure of instructional preference was an effective predictor of modality choice. The IPQ appears to be a useful tool for educational planners and administrators in formulating projections of modality choice patterns. No evidence was found to suggest that students placed by instructional preference pacing score will systematically outperform students placed by self-selection. Results regarding course completion rates were inconclusive. (SF)

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A Comparison of Personalized Instruction and Lecture/Discussion Courses In Electrical Engineering with Self-Selection of Treatment

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Abstract

This study explores the effects of student instructional preference on performance in an engineering course offered by PSI and lecture/discussion modalities. In lieu of random assignment to treatments, this investigation employs self-selection which is more common in higher education. The "pacing" scale on an Instructional Preference Questionnaire was found to significantly predict modality choice. With GPA as a covariate, students in lecture/discussion mode displayed superior examination performance; however, no interaction between instructional preference and treatment was observed. Although completion rates were equivalent across treatments, course completion by individual students could be weakly predicted by "pacing" preference score and GPA.

A Comparison of Personalized Instruction and Lecture/Discussion Courses In Electrical Engineering with Self-Selection of Treatment

The plethora of literature and reviews of literature comparing the personalized (PSI) and lecture/discussion modes of instruction has emphasized random assignment of student to treatment to maintain experimental rigor and maximize interpretability of results. In Robin's (1976) report of 39 such studies, only two chosen for review entailed student self-selection of treatment; the remainder employed random assignment, administrative assignment, or cross-semester control. Taveggia's (1976) review and the review by Kulik and Kulik (1975) similarly favor traditionally experimental procedures. Yet, the natural setting of higher education is characterized by free student choice of courses and, when available, of instructional modalities as well. This raises the major issue addressed by this investigation: whether the results which strongly favor PSI under conditions of random assignment replicate when students are given free choice. Whenever random assignment occurs, some students find themselves in the modality they would not have chosen. When these students are moved to the treatment of choice, does the aggregate character of the outcomes change?

The analysis is undertaken with, and to some extent despite, recognition that free student choice of treatment generates groups which are not necessarily equivalent statistically. The possibility then arises that any significant differential observed may be caused by attributes of the students choosing a modality rather than by the

modality itself. We will control for this to some extent using covariate analysis, but even a multiplicity of covariates cannot compensate fully for lack of randomization when the investigators exercise no control over entry of subjects into treatment groups (Kerlinger, 1973: Overall & Woodward, 1977). The sub-sample of undergraduate engineering students in each treatment group generalizes to hypothetical "universes" of students who, given a choice, would choose a particular modality. The treatment in this hypothetical sense may be seen as a composite of the instructional modality chosen and the individual attributes which determine the choice. The intent of this approach is to generate a study with greater ecological validity (Snow, 1974).

This investigation will explore a number of questions revolving about the issue of student performance in an environment of free modality choice. In particular:

1. Can modality choice be predicted? The Friedman-Stritter Instructional Preference Questionnaire (IPQ) will be explored as an instrument with potential predictive validity (Note 1, Note 2).

2. Are there differences in final examination performance by self-selected treatment group? Previous studies (Hursh, 1976; Kulik & Kulik, 1975; Robin, 1976; Taveggia, 1976) emphasizing random or administrative assignment have consistently revealed superior results for students taking a course by PSI.

3. Do students whose choice of instructional modality "matches" their instructional preference, as assessed by the Friedman-Stritter

IPQ, demonstrate superior final examination performance? Elucidation of this question requires a search for an ATI analogous to that found by Daniels and Stevens (1976) in a study of locus of control and randomly-assigned instructional modality.

4. Issues of performance aside, are students better "matched" to self-selected modality more likely to complete the course? Differential dropout rates have always been an important issue in PSI research (McKeachie & Kulik, 1975). The unit-mastery feature of PSI causes many students who would otherwise perform poorly on the final examination not to finish the course and thereby not take the final. Because such experimental mortality may be a source of invalidity in some past research, this analysis considers dropout as an explicit dependent variable.

Study Setting and Instrumentation

Occasion to investigate the questions described above was provided by the XPRT project headquartered at Drexel University, through which a number of parallel PSI and lecture/discussion courses in engineering have been offered. The particular course under discussion here is E524 "Electrical Engineering I" as offered at Drexel University during the summer term of 1977. It is a required sophomore course for majors in electrical engineering at Drexel, a required pre-junior (year 3 out of 5) course for students in mechanical engineering, and a required junior (year 4) course for students in computer science.

On the initial day of classes, students pre-enrolled for E524 (N = 113)were given a "neutral" introduction to the lecture/discussion

and PSI modalities and were offered both the choice of modality and the opportunity to transfer sections anytime within the first seven weeks. Initially, 60 students elected the lecture/discussion section and 53 the PSI. Five ultimately transferred, making the stable composition 61 in the lecture group and 52 in PSI. Students majoring in electrical engineering and students with prior PSI experience were found more likely to choose PSI than counterparts in other disciplines or with no prior PSI experience. The mean GPA's of the two groups did not differ statistically (mean for PSI = 2.75, mean for lecture = 2.57, $t = 1.82$, $df = 111$, $.10 > p > .05$ for two-tailed test).

The instructional modes themselves were organized in a customary manner. The lecture/discussion section met once each week as a full group and twice each week in smaller discussion sections of approximately 30 students each. Material was presented through lecture and textbook, supplemented by problem assignments. Performance was assessed by two one-hour quizzes in addition to the final examination. The PSI section incorporated all defining features as originally described by Keller (1968): individual student pacing, mastery of individual units as a criterion for advancement, student proctors, printed study guides, and lectures in a supplementary role.

Different instructors were responsible for each section; however, each had taught this course more than 20 times in the past. Furthermore, the instructor responsible for the lecture/discussion had previously offered the course by PSI and vice versa. The same textbooks were used for each section and the instructors had achieved virtually

perfect agreement regarding course objectives. While this instructor factor is clearly a source of uncontrolled variance, compensation was of the greatest degree possible given the administrative constraints under which the study was conducted.

Prior to modality selection, the 1976 version of the Friedman-Stritter Instructional Preference Questionnaire was administered to 109 of the 113 students. This instrument, as previously applied in other professional settings, was found to measure four traits of student instructional preference with acceptable levels of content and construct validity and reliability (Note 1). The IPQ scale particularly relevant to this study was extent of student preference for self-paced vs. group-paced instructional modalities, as this is the dimension on which the two treatment groups differ most saliently. Using coefficient Ω of Heise of Bohrnstedt (1970) appropriate to factor-analytic scales, a reliability of .704 was obtained for the "pacing" scale of this version of the IPQ.

The final examination administered to 86 (of the original 113) students at the end of the course consisted of seven problems, each with multiple subsections. Four of these problems were intended to measure student mastery of basic course material, while three assessed student ability to apply the basic concepts to unfamiliar situations. The reliability (Cronbach's α) of the total test scored by summing individual item scores was .704. Mean score on the test was 49.0%.

Results

This section will report results pertinent to each investigative issue in turn:

Table 1 presents a cross-tabulation of treatment by IPQ pacing score categorized into quartiles based on 109 students, the lowest quartile corresponding to a preference for group pacing and thereby indicating a "match" to the lecture section.[1] As seen in the table, the cross-tabulation yielded a significant relationship ($\chi^2 = 19.4$, $df = 3$, $p < .001$) suggesting that IPQ pacing scores can predict modality choice. If students in the first and second quartiles are considered "matched" to the lecture modality and those in the third and fourth matched to PSI, the IPQ would have correctly predicted the choice of 77 of 109 students (70.6%).

Insert Table 1 about here

Research questions two and three were concurrently investigated using analysis of covariance, with treatment group (two levels) and pacing quartile score (four levels--computed for 86 students taking the final exam) as independent variables, GPA as a covariate, and total final examination score as the criterion variable.[2,3] Table 2 summarizes the resulting analysis which reveals a significant covariate effect ($p < .001$), no direct effect by pacing quartile score, and no significant interaction between treatment and pacing preference. However, adjusted mean final exam scores were significantly higher ($p < .02$) for the lecture/discussion group than for the PSI group.

The unadjusted means (46.1% for PSI; 51.7% for lecture/discussion) did not differ significantly ($t = 1.89$, $df = 84$, $.10 > p > .05$ for two-tailed test); however, the standard error of the test (5.3%) is exceeded by the mean group difference, a finding which lends some practical significance to the result of the covariance analysis.

Insert Table 2 about here

We now address the fourth investigative question dealing with dropout rates. Of 86 students taking the final examination on the scheduled date at the end of the term, 45 represented the lecture/discussion section for a retention rate of 73.7% while 41 represented the PSI section for a retention rate of 78.8%, an insignificant difference. To investigate the effect of goodness-of-fit to instructional preference in predicting course completion, a "match" index was computed as follows: (a) for PSI students, "match" = pacing quartile - 1; (b) for lecture students, "match" = 4 - pacing quartile. Thus students with a match score of "3" had highly compatible treatments and instructional preference scores, while students with a match score of "0" displayed corresponding incompatibility. Because of the power of the IPQ pacing scale to predict choice, the distribution of "match" scores was skewed toward the high end.

Table 3 presents a cross tabulation of match index scores by the binary trait of course completion. Although there appears to be a trend in the direction of higher match scores generating greater completion rate, the effect is insignificant ($\chi^2 = 5.63$, $df = 3$,

$p = .13$). When the same analysis is performed for each treatment group separately, similar results obtain. To further investigate this issue, match index scores and GPA were loaded into a discriminant analysis with course completion as the criterion. The resulting discriminant function, although significant ($\chi^2 = 9.69$, $df = 2$, $p < .01$), resulted in correct prediction of course completion for 64% of cases.[4] We conclude that, taken together, match to instructional preference and GPA are marginal predictors of course completion.

Insert Table 3 about here

Conclusions and Implications

While clearly in need of validation through replication, the preeminent finding of this study relates to the superior performance of the lecture students on the common final examination after adjusting for GPA. It is possible that the beneficial effects of PSI, so clear in randomized studies, attenuate under conditions of free student choice. From the observed results, one might argue that in randomized studies, the students placed in PSI who would otherwise not have chosen PSI systematically outperform the students placed in lecture who would not have chosen that modality. Research to replicate this result could most productively make "mode of choice" an explicit variable in a randomized design.

Another possible explanation of this result is lack of experimental control, particularly as it relates to preparation for and administration of the examination under the different treatments

(Kaplan, 1978). To explore this issue, one of the authors interviewed a number of students. Student opinions, which must be taken as suggestive,indicate that three factors may have inhibited exam performance by the PSI group. The first factor raises the possibility that students in the lecture/discussion group were cued to exam content to a greater extent than their colleagues in the PSI group. Such bias can be inadvertantly introduced if the lecture instructor is aware of the detailed content of the exam; and in this case the exam was jointly developed by the lecture and PSI instructors. By contrast, the PSI instructor has no corresponding opportunity for cueing students to exam content unless he/she purposely alters the written study guides. The second factor is that lecture students had occasion to practice examination-taking on the course material through two hourly quizzes not required of the PSI group. Problems on the unit-tests taken by the PSI students were dissimilar in length and format to the problems on the examination. Third, many PSI students were guaranteed high grades even before taking the examination, and thus had less incentive to prepare. These factors combine to underscore the need for replication of this analysis prior to final interpretation of the results.

The attitudinal meaaure of instructional preference does predict modality choice with a significant degree of precision. It can be presumed then that the Instructional Preference Questionnaire can be useful to educational planners and administrators in formulating projections of modality choice patterns. Also, one might expect student affect not assessed in this study to be superior when students are

matched to their instructional preference. No interaction was found to suggest that students strictly placed by instructional preference pacing score will systematically outperform students placed by self-selection.

The results regarding course completion rates were not conclusive; however, the comparable dropout rates of the two sections does to some degree contradict the common belief that high dropout rate is a "given" of PSI.

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Footnotes

[1]This categorization of pacing scores anticipates later analysis of the fourth investigative question.

[2]An alternative covariate, class-rank quintile within major within graduating class, was potentially more appropriate because GPA's vary systematically within major departments. However, it was not used because of its ordinal metric and because it correlated so strongly with GPA ($r = .933$).

[3]Performance on individual exam items varied insignificantly across treatment groups.

[4]GPA was a stronger contributor (coefficient = .85) to the standardized discriminant function than "match" index (coefficient = .52).

Table 1

Crosstabulation of Selected Treatment by
Pacing Preference Quartile

Treatment Selected	Pacing Preference Quartile[a]			
	1	2	3	4
Lecture/Discussion	21	19	10	8
PSI	6	8	17	20

Note: $\chi^2 = 19.4$, df = 3, $p < .001$

[a]Lower-numbered quartiles indicate preference for group-pacing; higher numbers indicate preference for self-pacing.

Table 2

Analysis of Covariance

on Final Examination Scores (N = 86)

Source	df	MS	F	Significance
GPA (Covariate)	1	7.32	28.06	$p < .001$
Treatment	1	1.73	6.62	$p < .02$[a]
Pacing Quartile	3	.12	.46	NS
Treatment X Pacing Quartile	3	.14	.54	NS
Residual	77	.26		

[a]Adjusted standard scores for treatment groups:

PSI = -.18; Lecture/discussion = .16.

Table 3

Crosstabulation of On-Time Course

Completion by "Match" Index

Completed Course On-Time	"Match" Index[a]			
	0	1	2	3
Yes	9	12	32	33
No	5	6	4	8

Note: $\chi^2 = 5.63$, df = 3, NS

[a]A high value indicates agreement between IPQ "pacing" score and the modality selected.